Design of an Integrated-System FARAD Thruster

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ABSTRACT:
Pulsed inductive plasma accelerators are spacecraft propulsion devices in which energy is stored in a capacitor and then discharged through an inductive coil. The device is electrodeless, inducing a current sheet in a plasma located near the face of the coil. The propellant is accelerated and expelled at a high exhaust velocity (order of 10 km/s) through the interaction of the plasma current and the induced magnetic field.

The Faraday Accelerator with RF-Assisted Discharge (FARAD) thruster[1,2] is a type of pulsed inductive plasma accelerator in which the plasma is preionized by a mechanism separate from that used to form the current sheet and accelerate the gas. Employing a separate preionization mechanism allows for the formation of an inductive current sheet at much lower discharge energies and voltages than those used in previous pulsed inductive accelerators like the Pulsed Inductive Thruster (PIT).

In this paper, we present the design of a benchtop FARAD thruster with all the subsystems (mass injection, preionization, and acceleration) integrated into a single unit. Design of the thruster follows the guidelines and similarity performance parameters presented in Refs. [3,4]. The system is designed to use the ringing, RF-frequency signal produced by a discharging Vector Inversion Generator (VIG) to preionize the gas. The acceleration stage operates on the order of 100 J/pulse and can be driven by several different pulsed powertrains. These include a simple capacitor coupled to the system, a Bernardes and Merryman configuration, and a pulse-compression circuit that takes a temporally broad, low current pulse and transforms it into a short, high current pulse. A set of applied magnetic field coils are integrated into the system to guide the preionized propellant as it spreads over the face of the inductive acceleration coil. The coils are operated in a pulsed mode, and the thruster can be operated without using the coils to determine if there is a performance improvement gain realized when an applied field is present.

REFERENCES

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